REMARKS

Claims 1, 10 and 18 have been amended. Claim 13 has been cancelled without prejudice or disclaimer. New claims 24 and 25 have been added. Entry of the foregoing amendments and reconsideration of the present application are respectfully requested. The amended claims have been amended to place them in more conventional format for claims directed to this type of composition/article, to achieve greater clarity but without materially changing the scope of those claims. Consequently, it is believed that no new issues have been raised after Final Rejection.

Rejections under 35 U.S.C. § 103

Claims 1, 3-18 and 20-23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,693,203 to Ohhashi et al. (hereafter "Ohhashi"). Applicants respectfully traverse this rejection for the following reasons.

By way of background, the present invention is directed to a sputtering target. One object of the invention is to provide a sputtering target that, when applied to dual damascene interconnection technology to form an Al interconnection film, enables improved electrical characteristics and quality of a Nb liner film for the Al film. In particular, the object is to provide a Nb sputtering target that enables one to obtain, with reproducibility, a Nb film capable of suppressing the increase in resistivity of an Al interconnection film to, for instance, $4\mu\,\Omega$ cm or less and the occurrence of dust (see present specification, page 3, line 22 to page 4, line 4).

As a result of intensive studies, the inventors have determined important parameters in solving the above problems. Namely, the inventors have found that in high purity Nb sputtering targets, the <u>dispersion</u> and content of Ta in the Nb target, the Nb <u>average grain size</u> and the grain size ratio of adjacent grains in the Nb target, and the <u>dispersion</u> and content of oxygen in the Nb target are important parameters. These parameters are implemented in the sputtering targets of independent claims 1, 10, and 18, which recite, respectively, the content and <u>dispersion</u> of Ta, <u>grain size</u> parameters,

and the content and dispersion of oxygen which provide an improved Nb sputtering target.

Claims 1 and 18

Claim 1 has been and continues to be directed to a sputtering target consisting essentially of Nb comprising an amount of Ta, wherein the Ta content is 3000 ppm or less and wherein the dispersion of the Ta content in the target is within 30%. Both the Ta content and Ta content dispersion as recited in claim 1 are important. The Ta content alone is not a sufficient parameter to control in the Nb sputtering target. For example, although the Ta content of example 3 of Table 1 is only 1830 ppm, a relatively high resistivity results because of the poor dispersion of the Ta in that example.

Claim 18 has been and continues to be directed to a sputtering target consisting essentially of Nb comprising an amount of oxygen, wherein the oxygen content is 200 ppm or less and wherein the dispersion of the oxygen content in the target is within 80%. Both the oxygen content and oxygen content dispersion as recited in claim 18 are important. The oxygen content alone is not a sufficient parameter to control. For example, although the oxygen content of example 1 of Table 3 is only 10 ppm, the resistivity of the interconnection formed using the sputtering target is 4.2 $\mu\,\Omega$ cm, which exceeds the target value of 4.0 $\mu\,\Omega$ cm due to the dispersion of oxygen content of 82% which exceeds 80%.

Ohhashi fails to teach or suggest controlling either the dispersion of oxygen content or the dispersion of Ta content for a Nb sputtering target. Specifically, Ohhashi fails to disclose or suggest controlling the dispersion of Ta content in a Nb sputtering target to be within 30% in contrast to claim 1, or the controlling the dispersion of oxygen content in a Nb sputtering target to be within 80% in contrast to claim 18. Therefore, aside from any other issues regarding the patentability of these claims, it is clear on this record that the prior art is devoid of any teaching whatsoever of a specifically claimed parameter. Thus, the rejection is improper and should be withdrawn.

The Office Action suggests that a zero content of Ta or O would result in a zero % content dispersion stating:

> The recited O and Ta contents read on zero which suggests said elements could be eliminated from the sputtering target. Then the maximum and minimum values of said elements is zero. Thus, the dispersion % of said O and Ta is zero.

First, Applicants submit that the Office Action is not precisely correct in suggesting that a zero content of Ta or O (even if this were possible, which it is not) would result in a zero % content dispersion, because in the limit as the content approaches zero the dispersion would not be zero unless the ratio of the maximum and minimum values is equal to one. Thus, the rejection is based on an incorrect factual premise.

Secondly, the PTO attempts to give Applicants' claims an impossible and, hence, unreasonable scope of interpretation. As is well known to persons skilled in the art, and as noted at page 7, lines 16-22, of the present application, Nb normally contains amounts of Ta as impurities, since it is "not easy to separate Ta from Nb." Thus, the PTO's attempt to read the claims as including 0 % Ta is artificial, incorrect and not reasonable in light of the level of skill in the art, not to mention the specification. Claims calling for the presence of an "amount" or "content" of a normally-present impurity of less than a stated value are normally interpreted as requiring some amount of that impurity. It is not required to state some arbitrary lower level for these impurities, inasmuch as it is often not even possible to measure amounts at the lower end of the usual presence of these impurities. This requirement places unreasonable burdens upon applicants and is not representative of PTO practice.

In any event, Applicants have amended claims 1 and 18 to make it expressly clear (if it wasn't already clear) that the claimed sputtering targets do contain some amount of Ta or oxygen as impurities. Thus, the present claims 1 and 18 exclude the possibility of either a content of zero or of any question of a dispersion % of zero possibly resulting from such a zero content.

Moreover, Ohhashi certainly fails to suggest that the impurities of Ta and oxygen can be totally eliminated from a Nb sputtering target, or how this would be

accomplished. This is entirely consistent with the notion that persons skilled in the art would not understand that the present claims can be read on a zero % content of either Ta or oxygen.

Furthermore, the Office Action again (as in the prior Office Action) grounds its reasoning for obviousness in part on the principle that "optimization of a variable *recognized in the art as a result-effective variable* normally is considered to be within the ordinary skill in the art." Again, while Applicants do not quarrel with the statement of the general principle, they do point out that the present record is devoid of any evidence that those skilled in this art recognized that the claimed parameters were "result-effective" for the results sought after by the Applicants. Thus, this principle of law has no application to the present context. If the PTO continues to maintain this reasoning, Applicants respectfully request the PTO to point out where in the prior art the claimed parameters are recognized as "result effective."

Claim 10

Claim 10 recites parameters concerning the grain diameter size of a Nb target. Claim 10 recites a grain diameter in the range of 0.1 to 10 times an average grain diameter, and a grain size ratio of adjacent grains in the range of 0.1 to 10. Furthermore, claim 10 has been amended to recite that the average grain diameter is 100μm or less, a recitation from original claim 13, which has been canceled. As shown in Table 5 and discussed on pages 28-29 of the specification, a Nb target with the recited grain size parameters allows for suppressed occurrence of dust when sputtering.

Ohhashi fails to disclose a Nb target with the grain size parameters as recited in claim 10, or its attendant advantages in reducing dust. Ohhashi discloses that the sputtering target should have a uniform microstructure and a crystal grain size of no more than 350 μm. Ohhashi, however, does disclose a grain diameter in the range of 0.1 to 10 times an average grain diameter, or a grain size ratio of adjacent grains in the range of 0.1 to 10. Furthermore, Ohhashi fails to disclose or recognize that the Nb sputtering target should have an average grain diameter of 100μm or less in order to reduce dust. Because the reference fails to recognize either the problem or the

presently claimed solution for that problem, the reference cannot "teach" the present invention. Accordingly, the rejection of claim 10 based on Ohhashi should be withdrawn as well.

New claims 24 and 25

New claim 24 incorporates subject matter from original claims 1 and 9. New claim 25 incorporates subject matter from original claims 18 and 17. New claims 24 and 25 both recite that the sputtering target is for forming a Nb liner film of an Al interconnection film in applying dual damascene interconnection technology. Ohhashi fails to disclose or suggest that the Ohhashi sputtering target is for forming a Nb liner film of an Al interconnection film in applying dual damascene interconnection technology. Thus, Ohhashi fails to suggest at least these limitations of claim 24 or 25.

In view of the forgoing amendments and comments, Applicants respectfully request reconsideration and withdrawal of the various rejections based on the prior art.

Consequently, further and favorable consideration of the application, in the form of a Notice of Allowance of all claims is believed to be next in order, and such action is respectfully solicited. In the event that one or more minor matters remain for resolution, the Examiner is invited to telephone the undersigned at the number given below.

Respectfully submitted,

Date January 23, 2003

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MARKED-UP PORTIONS OF SPECIFICATION AND CLAIMS SHOWING CHANGES MADE

IN THE CLAIMS:

1\. (Thrice Amended) A high purity Nb sputtering target consisting essentially of [high purity] Nb [, comprising an amount of Ta, wherein the Ta content is 3000 ppm or less,] containing an amount of Ta impurity dispersed therein, the amount of Ta in the target being 3000 ppm or less, wherein a dispersion of the Ta content in the target is within 30%, the dispersion of the Ta content being defined by the following equation, for measured content values in the target:

dispersion (%) = {(maximum value - minimum value) / (maximum value + minimum value)} X 100.

10\. (Twice Amended) A sputtering target consisting essentially of high purity Nb: wherein the target has Nb grains having an average grain diameter of 100μm or less, and wherein each grain constituting the Nb target has a grain diameter in the range of 0.1 to 10 times [an] the average grain diameter, and a grain size ratio of adjacent grains is in the range of 0.1 to 10.

18\. (Thrice Amended) A high purity Nb sputtering target consisting essentially of [high purity] Nb [comprising an amount of oxygen, wherein the oxygen content is 200 ppm or less,] containing an amount of oxygen as an impurity dispersed therein, the oxygen content in the target being 200 ppm or less, wherein a dispersion of the oxygen content in the target is within 80%, the dispersion of the oxygen content being defined by the following equation, for measured values in the target:

dispersion (%) = {(maximum value — minimum value) I (maximum value + minimum value)} X 100.